

## A preliminary study of everted vesicae of several leafrollers (Tortricidae)

BOYAN ZLATKOV

Sofia University, Faculty of Biology, Department of Zoology and Anthropology,  
8, Dragan Tsankov Blvd., 1164 Sofia, Bulgaria; bzlatkov@gmail.com

**Abstract.** In this study the everted vesicae of 23 tortricid species belonging to all European tribes with the exception of Euliini (Tortricini, Cochylini, Cnephasiini, Archipini, Sparganothini, Polyorthini, Bactrini, Olethreutini, Enarmoniini, Eucosmini, and Grapholitini) are described. In all investigated species, the vesica is tubular with the gonopore located terminally or subterminally, with the exception of the representatives of Cochylini, in which the diameter of the vesica vastly exceeds the diameter of the phallus and the gonopore is located laterally. The vesica appears to be non-eversible in many Eucosmini. Two main types of cornuti are observed: 1) special sclerotised projections of the vesica typical for examined Cochylini, and 2) modified deciduous or non-deciduous (fixed) setae in Archipini, Enarmoniini, Eucosmini and Grapholitini. Several modifications improving the injection eversion technique of Dang (1993) are described.

### Introduction

The taxonomic significance of the morphology of everted vesica (endophallus) is well known. It is used for taxonomic purposes in many lepidopterous families (Matthews, 1998). Recently, examination of this structure has been applied to resolve some taxonomic problems and to complement descriptions in some microlepidopterous families such as the Pyraloidea (e. g. Ferris 2004; Ferris & Nordin 2004). The first attempts at studying the everted vesica of Microlepidoptera were implemented by Dang (1993). He successfully everted vesicae of 12 species in four families (Tortricidae, Oecophoridae, Gelechiidae, and Nepticulidae) introducing two original techniques. The author described the vesicae of 9 tortricid species. Scattered illustrations of vesicae can be found in other works, e.g. Baixeras (1992, 2002). Later, Brown (2003) illustrated vesicae of 10 species of genus *Orthocomotis*. In his work the vesicae were everted but not inflated, and the three-dimensional structure is not visible. With the exception of the Dang's work (*op. cit.*), no special investigations on the three-dimensional structure of the tortricid vesica have been attempted. In the present study the vesicae of 23 representatives of all European tribes except the Euliini are described and illustrated. Although the number of examined species is insufficient to draw general conclusions, some aspects of the morphology of the tortricid vesica are discussed. They may serve as basis of further studies.

### Material and methods

Materials from the following collections were dissected: collection of the author, preserved in the Department of Zoology and Anthropology, Sofia University "St. Kliment Ohridski" (all species except *Pelatea klugiana*); National Natural History Museum, Sofia (*P. klugiana* only).

In this study the classification of Razowski (2002, 2003) is used.

For vesica eversion a modified version of the injection method of Dang (1993) was applied. Dang's method requires a tiny hypodermic needle with a modified tip. Instead of metal needles, self-made glass needles (capillaries) were used. The main advantage of the capillary is that its diameter can be accurately adjusted to the diameter of the phallus. Moreover, a separate capillary for each individual phallus may be prepared very easily.

**Preparing of capillary.** The glass capillaries are made from an ordinary glass tube (diameter 3–4 mm) by heating it with a spirit-lamp flame and pulling in opposite directions. The glass tube should not be made from fireproof glass, otherwise pulling is very difficult. After the first pulling, the diameter of the capillary usually is about 0,5–1 mm. In order to achieve a smaller diameter the capillary should be heated and pulled again. In this way, a very fine capillary (0,05 mm or even narrower) can be obtained (Fig. 1). The wide part of glass tube should not exceed 3–4 cm in length, so if necessary it should be shortened by using a glass cutter. The cutting edge of the tube is heated in a flame until it becomes round. The diameter of capillary varies in length and it can be cut by scissors (under water to protect eyes from small glass fragments!) at a point where the diameter is as desired. The diameter of capillary should be only a little smaller than the diameter of the phallus to be examined.

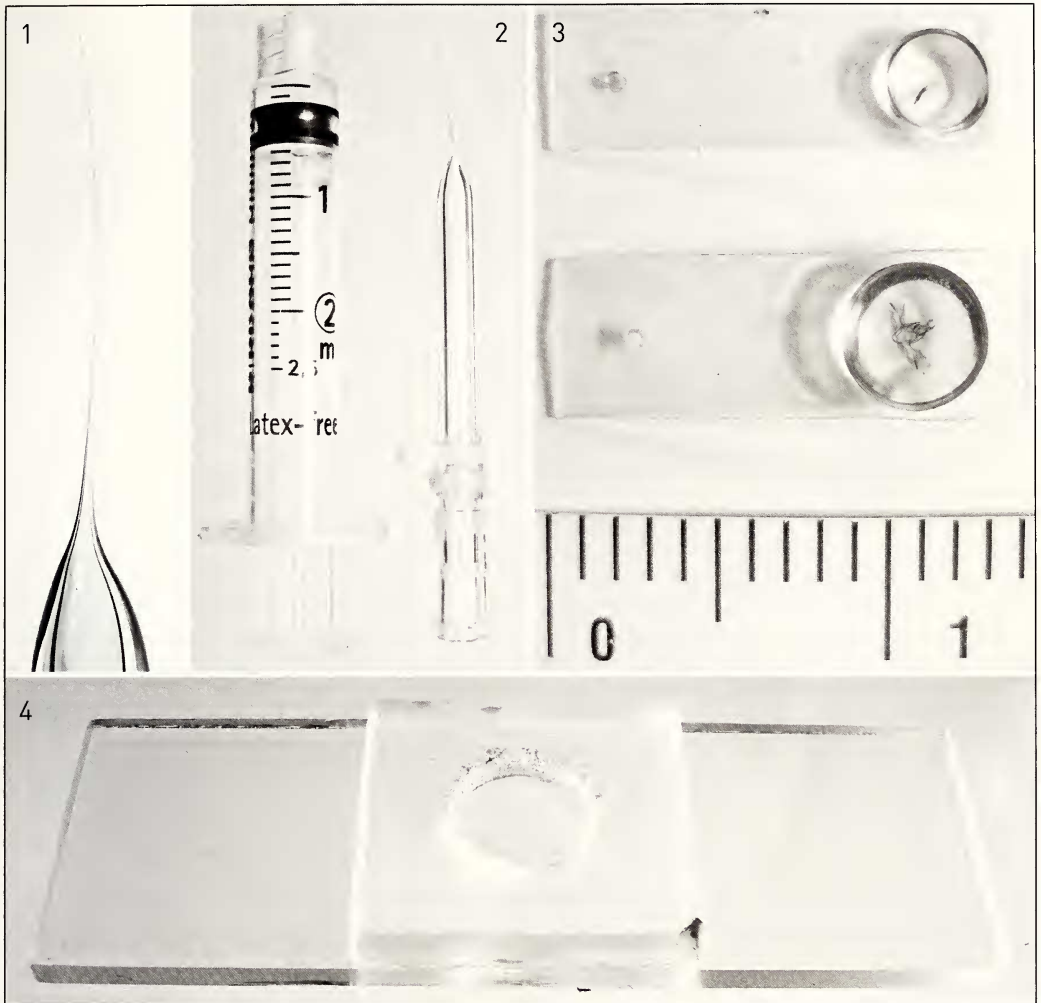
The prepared capillary is attached to a syringe (5–10 ml) by plastic female luer with hose (Fig. 2). Instead of syringe, a special device may be used (see Lange 1963), but it is very difficult to prepare this without special knowledge.

**Technique of eversion.** As previously mentioned, the technique of Dang (1993) was used but with several modifications. The genitalia are extracted by standard procedure: the abdominal segments are macerated in boiling 10% KOH and cleaned. To avoid repeating Dang's methodology only differences in the technique are mentioned here.

After neutralization with glacial acetic acid, the phallus is transferred to a solution of Chlorazol black (0,03% in 70% ethanol). After 2–5 min the phallus is transferred to 70% ethanol for 1 minute. Immersion in the 70% ethanol bath is repeated to remove the staining solution. The phallus is then transferred to 5% ethanol for 1 minute. This procedure fully restores the softness of the vesica. Whilst the phallus is still submerged in 5% ethanol, the capillary, filled with absolute ethanol, is inserted into the phallus. Slight pressure is applied on the syringe. The syringe is then removed, together with the phallus and maximal pressure immediately applied to the syringe to inflate the vesica. The sudden pressure might eject the phallus, so this step should be carried out over a dish containing absolute ethanol. A continuous flow of alcohol is maintained for a few seconds to harden the vesica. The the phallus is then removed from the capillary and put it in absolute ethanol for a few seconds. Finally, the phallus is transferred to isopropanol. If necessary, the inflation is repeated, but this time with isopropanol.

The next step follows Dang's method.

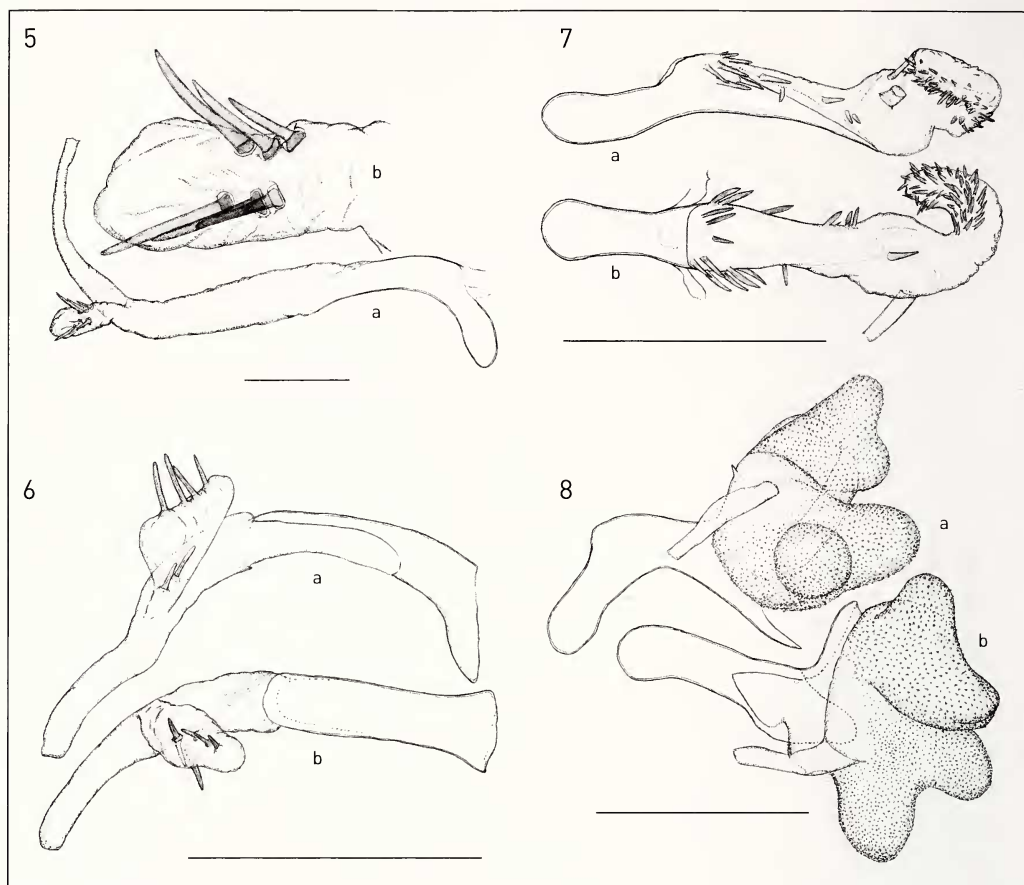
The everted vesica is embedded in a drop of Euparal and placed in a self-made hemispherical plastic container (Fig. 3) pinned underneath the specimen. In this way the vesica is enclosed in permanent medium without deformation. The other genital parts are preserved in the same way.



**Figs 1–4.** Equipment for vesica eversion. **1.** Self-made glass capillary. **2.** Capillary with plastic female luer and syringe. **3.** Plastic containers with genitalia. **4.** Slide for photography.

By experiment, I have found that in many species eversion is often only possible during the first 3–5 min after maceration of the genitalia. In many cases, 10 min after the transfer from KOH solution into 5% ethanol the vesica becomes non-eversible, especially in small specimens. Even if the vesica is successfully everted with 5% ethanol, it may remain flattened if it is not treated with absolute alcohol immediately after eversion. One possible reason for this phenomenon could be changes of the proteins in the thin cuticle of the vesica caused by a change in alkalinity. In addition, vesica eversion of old museum specimens is much more difficult than eversion of fresh specimens.

**Drawing of illustrations.** The drawings were prepared from photographs taken by a digital camera mounted on transmitted light microscope. Inflated vesicae taken from the isopropanol were embedded into a thick layer of Euparal on a special slide (Fig. 4) and photographed immediately. The contours of photographed objects



**Figs 5–8.** Everted vesicae of Tortricidae. **5.** *Tortrix viridana*. a. Right view. b. Detail of diverticulum. **6.** *Acleris boscanoides*. a. Right view. b. Dorsal view. **7.** *Obraztsoviana maculosana*. a. Left view. b. Dorsal view. **8.** *Aethes tornella*. a. Left view. b. Dorsal view. Scale = 0.5 mm.

were copied onto tracing paper in pencil and then the detailed structure was drawn from direct observation. Completed pencil drawings were digitalized and edited using Adobe Photoshop CS software.

Everted vesicae are drawn mainly in two aspects: lateral (left) and dorsal. In a few cases, the vesica is illustrated in right or ventral aspect in order to get a better view of some important characters.

## Results

### Descriptions of everted vesicae

Two important measurements are used for description: length of phallus (Lph) and length of vesica (Lv). Lph is the length of the sclerotised part of the phallus which is non-invertible (in some species there is a sclerotised part which is inverted, but eversi-



ble!). Lv is the distance between the distal part of the phallus and the most distal part of the vesica, including diverticula. These measurements are only tentative and should not be treated as absolute. Often the vesica merges into the ductus ejaculatorius without a distinct boundary. In these cases, the length is defined approximately. Usually the ductus takes up the stain more readily than the vesica and so is more intensively coloured, or it is a little narrower than the vesica; these two factors may be helpful in determining the junction between them. In most cases more than one specimen from a species was examined; where it was possible only to look at a single example, this is noted.

In this paper the term “diverticulum” is used to designate the bag-like expansions of the vesica. Kristensen (2003) refers to these structures as the “outpocketings”, but the first term is very common in taxonomic literature for Macrolepidoptera (especially Noctuidae) and is preferred here.

### ***Tortrix viridana* Linnaeus, 1758**

**Fig. 5**

Lph = 0,87 mm, Lv ~ 1 mm. Phallus curved, with large coecum; vesica large, wider than the phallus, cylindrical, apically narrowed. Vesica bearing a large, bag-like diverticulum on right side near middle; right side of diverticulum with 6 cornuti in two regular and parallel rows. The cornuti are stout, heavily sclerotised non-deciduous and conical, with large bases (sockets) and no neck (neck is a constriction at base). The proximal cornuti are almost half the length of the distal ones.

### ***Acleris boscanoides* Razowski, 1959**

**Fig. 6**

Lph = 0,42 mm, Lv ~ 0,28 mm. Phallus cylindrical, slightly ventrally curved, with a long semi-membranous area which is part of the vesica when everted, on the ventral side and a relatively large, ventrally-pointed coecum; vesica is also cylindrical, shorter than the phallus and bears a large diverticulum beginning subdorsally from the right side; diverticulum heart-shaped in lateral view with two groups of long, stout, non-deciduous cornuti similar to these in *T. viridana*. The dorsal group consists of four and the lateral of two cornuti. A single cornutus is located ventrally on the vesica between the phallus and diverticulum.

### ***Obraztsoviana maculosana* (Haworth, 1811)**

**Fig. 7**

Lph = 0,63 mm, Lv = 0,26 mm. The phallus with long coecum (1/3 of the phallus' length), the opening is dorsally located. The distal half is dorsally membranous and formed by the vesica. The vesica has numerous hollow cornuti divided into three groups. The proximal group consists of 13 on the dorsal base of the vesica, mostly laterally, on both sides. The medial group consists of 4 cornuti one of which is the largest on the vesica. The distal group is formed from numerous relatively small cornuti. Vesica is bulbous in the medial area and cylindrical in the distal part. The bulbous part bears the longest cornutus, located dorsally. The distal half is curved to the right and

then anterad so that the apical part is anteriorly directed. The gonopore is narrow and located on the left side of the bulbous part of the vesica.

***Aethes tornella* (Walsingham, 1898)**

**Fig. 8**

Only one specimen was examined.  $L_{ph} = 0,6$  mm,  $L_v \sim 0,5$  mm. Phallus tubular, ventrally curved, with a relatively long coecum. A slightly sclerotised plate covers the distal half of the dorsal part of the vesica when it is inverted within the phallus. After eversion this plate is located on the right side. Phallus with spoon-like apex ventrally. Vesica huge compared to the phallus and has a complicated structure. It is divided into two large sections. The right section is dorso-laterally directed and bears three short and wide diverticula, one lateral and two medial, positioned one under another. The left section is directed laterally and bears two diverticula. The gonopore is located on the upper surface of the left section. There is a small slightly sclerotised process nearby. The whole surface of the vesica, with exception of the basal part, is covered with small weak spine-like processes (spinulae) which are smaller in size and denser on the left section.

***Cochylidia implicitana* (Wocke, 1856)**

**Fig. 9**

$L_{ph} = 0,5$  mm. Boundary between the phallus and vesica indistinct, so  $L_v$  was not measured. Phallus curved ventrally, with a very short coecum and a narrow terminally located opening. Coecum with two hemispherical prominences laterally. The distal part of the phallus bears a sharp, conical spine. The dorsal half is mostly membranous, cup-shaped, without a distinct border with the vesica. The basal region of the vesica is dorsally sclerotised and near to this region bears 10 hard, hollow cornuti, which are actually sclerotised projections of vesica. The next part of the vesica is directed at first to the right and then to the left. The surface of the distal half is covered with small non-sclerotised spinulae that are denser in the apical area. The apical area ends with a strobile-shaped structure on the left side consisting of numerous, dense weakly-sclerotised spines. The location of the gonopore is undefined.

***Eana canescana* (Guenée, 1845)**

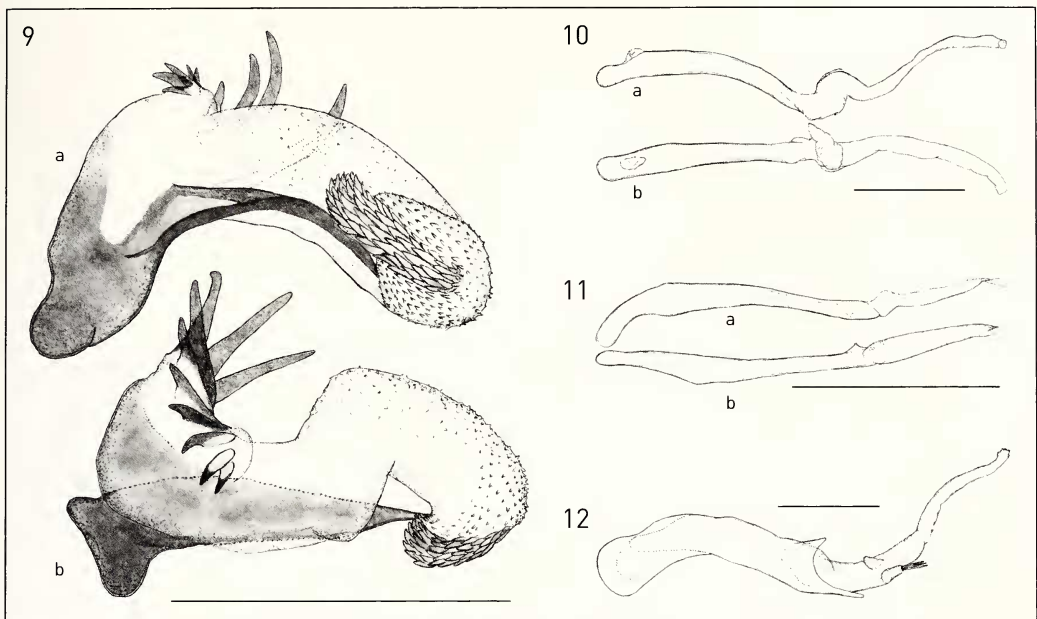
**Fig. 10**

$L_{ph} = 0,95$  mm,  $L_v \sim 0,3$  mm. Phallus tubular, slightly ventrally curved; vesica relatively simple, S-shaped (curved first dorsally then ventrally) bearing large conical diverticulum located dorsolaterally and directed to the right.

***Cnephasia cupressivorana* (Staudinger, 1871)**

**Fig. 11**

$L_{ph} = 0,68$  mm,  $L_v \sim 0,20$  mm. Phallus long and narrow (only 0,03 mm in the narrowest part), widened at the basal half near the dorsally located opening; coecum relatively



**Figs 9–12.** Everted vesicae of Tortricidae. **9.** *Cochylidia implicitana*. a. Left view. b. Dorsal view. **10.** *Eana canescana*. a. Left view. b. Dorsal view. **11.** *Cnephasia cupressivorana*. a. Left view. b. Dorsal view. **12.** *Ptycholoma lecheana*. Left view. Scale = 0.5 mm.

short and ventrally curved. The distal half of the right wall is mainly membranous with the exception of its medial region, which is well-sclerotised and has a small tooth near the end; vesica extremely simple, short and cylindrical, with small bulbous extension near the base.

### *Ptycholoma lecheana* (Linnaeus, 1758)

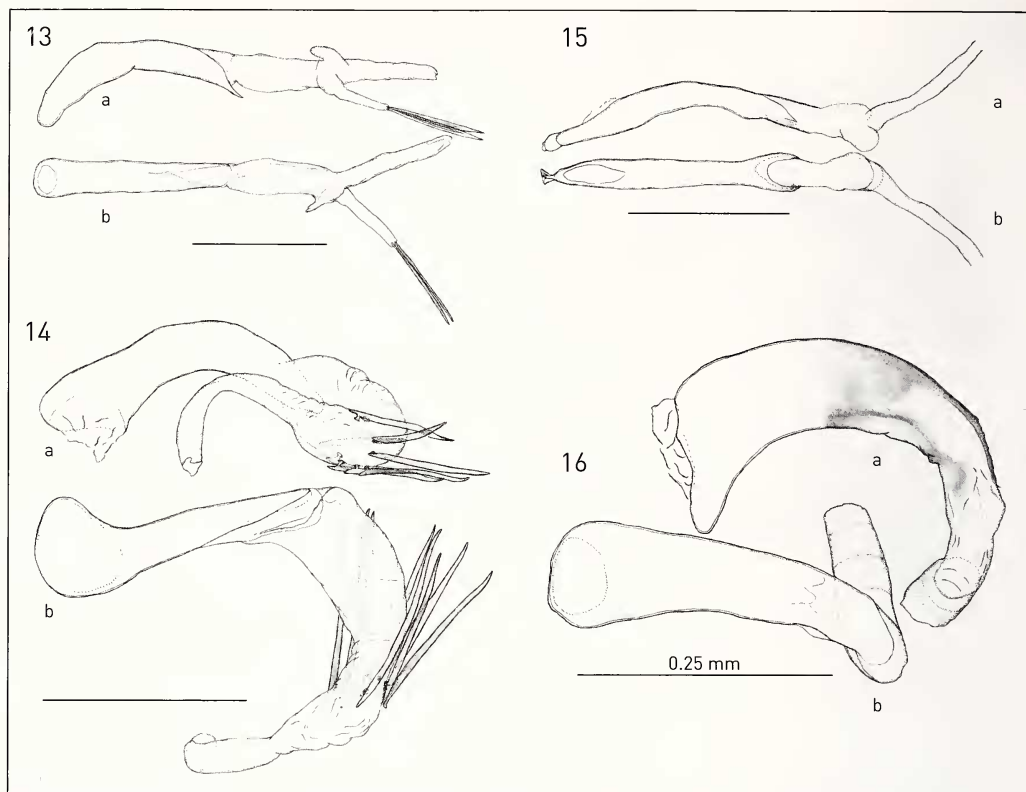
**Fig. 12**

Lph = 1,3 mm, Lv ~ 0,6 mm. Phallus fairly straight and laterally flattened; coecum with a large flat sclerotised envelope. The end of the phallus bears a larger ventro-terminal process and a smaller dorsal spine; vesica relatively short, small, with two diverticula on the left side. Dorsal diverticulum shorter and almost conical, directed anteriorly; ventral diverticulum finger-like, with 4 short cornuti (deciduous?) at its apex.

### *Aphelia ferugana* (Hübner, 1793)

**Fig. 13**

Lph = 0,76 mm, Lv ~ 0,4 mm. Phallus cylindrical, base ventrally bent, with short coecum, apex with short sharp ventral process; vesica also cylindrical, with constriction at the base, bearing two diverticula on the left side, one short and one long. The shorter one is directed antero-dorsally, and the longer one is directed postero-ventrally. The longer diverticulum ends with two long, deciduous, sword-shaped cornuti, ca. 0,36 mm long. The gonopore is located terminally.



**Figs 13–16.** Everted vesicae of Tortricidae. **13.** *Aphelia ferugana*. a. Left view. b. Dorsal view. **14.** *Sparganothis pilleriana*. a. Left view. b. Dorsal view. **15.** *Olindia schumacherana*. a. Left view. b. Dorsal view. **16.** *Bactra robustana*. a. Left view. b. Dorsal view. Scale = 0.5 mm.

***Sparganothis pilleriana* (Denis & Schiffermüller, 1775)**

**Fig. 14**

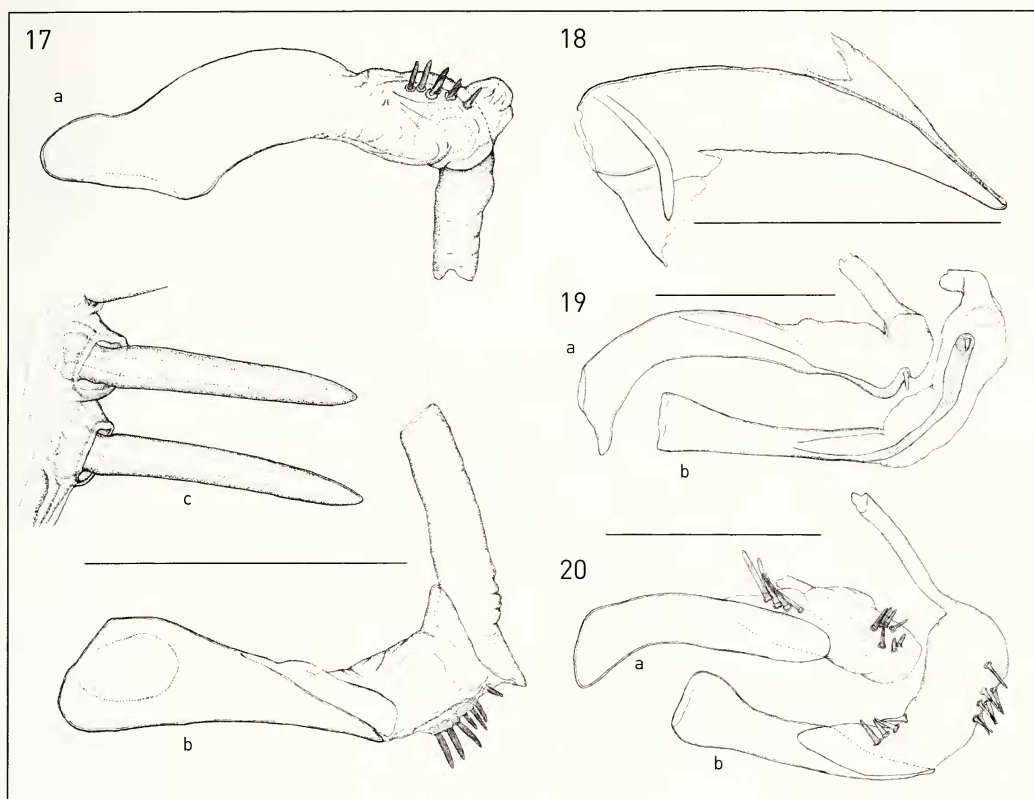
Only one specimen was examined. Lph = 0,7 mm, Lv ~ 0,6 mm. Phallus tubular, slightly laterally flattened and ventrally curved; opening wide, located ventrally. In this region the phallus forms a dome-like prominence on the right side. A weakly sclerotised plate is present at the distal end of phallus in its dorsal part. Vesica tubular, apically narrowed, with bulbous expansion at the distal third; bulbous expansion with eight sword-shaped deciduous cornuti, each ca. 0,43 mm long. The point of attachment of each cornutus is laterally located and divides the cornutus into two unequal parts. The shorter part posteriorly directed and curved at the end and longer (proximal) part almost straight. The attachment points of the cornuti are arranged alternatively, into two annular rows.

***Olindia schumacherana* (Fabricius, 1787)**

**Fig. 15**

Only one specimen was examined. Lph = 0,75 mm, Lv = 0,30 mm. Phallus tubular, slightly ventrally curved with two small, lateral claw-like processes at apex; coecum





**Figs 17–20.** Everted vesicae of Tortricidae. 17. *Endothenia marginana*. a. Left view. b. Dorsal view. c. Detail of cornuti. 18. *Lobesia indusiana*. Left view. 19. *Orthotaenia undulana*. a. Left view. b. Ventral view. 20. *Olethreutes arcuellus*. a. Left view. b. Dorsal view. Scale = 0.5 mm.

short with sclerotised basal apodemes; vesica very simple, without any sclerotised structures, tubular at the proximal part and widening at the distal part, with two short, wide diverticula dorsally and ventrally; ventral diverticulum larger than dorsal.

### *Bactra robustana* (Christoph, 1872)

**Fig. 16**

Lph ~ 0,23 mm. Phallus curved downwards and then bent to the left; coecum absent; vesica directed to the right, reduced and indistinguishable from the ductus ejaculatorius. There are two eversible sclerotised plates on the vesica: dorsal and left, divided by the membranous parts of the vesica. Three annular structures are visible on the ductus (possibly an artifact?).

### *Endothenia marginana* (Haworth, 1811)

**Fig. 17**

Only one specimen was examined. Lph = 0,50 mm, Lv = 0,25 mm. Phallus ventrally bent with a ventrally located, anterior opening; dorsally bearing a well sclerotised

carina; coecum short; diameter of vesica almost equal to the diameter of the phallus. The vesica has 7 fixed, dorso-lateral cornuti on the left side arranged into longitudinal rows; distal cornuti shorter than proximal cornuti. A collar-like, slightly sclerotised extension is present at the end of the vesica, around the gonopore. The extension forms very indistinct diverticula at left and at right. The cornuti are stout, each with a bulbous base set in a shallow pit and with an indistinct neck. Ductus relatively wide.

***Lobesia indusiana* (Zeller, 1847)**

**Fig. 18**

Lph = 0,7 mm. Phallus heavily sclerotised, apically pointed, slightly ventrally bent, with a short carina on the ventral aspect; distal half dorsally membranous. Vesica almost completely reduced, conical and directed anteriorly, without any specific structures. Although many specimens were examined, the location of the primary gonopore remains undefined.

***Orthotaenia undulana* (Denis & Schiffermüller, 1775)**

**Fig. 19**

Dang (1993) described the vesica of this species for the first time. Lph = 0,63 mm, Lv ~ 0,55 mm. Phallus slightly flattened laterally and ventrally curved, without a coecum and with two membranous sections: dorsal and ventral. There is an extension of the wall of the phallus starting venterolaterally from the left side and ending on the ventral side of the vesica. A stout cornutus with socketed base present at the end of this sclerotised band. Vesica cylindrical, bent to the left; gonopore sunk between two short and wide, indistinct diverticula.

***Olethreutes arcuellus* (Clerck, 1759)**

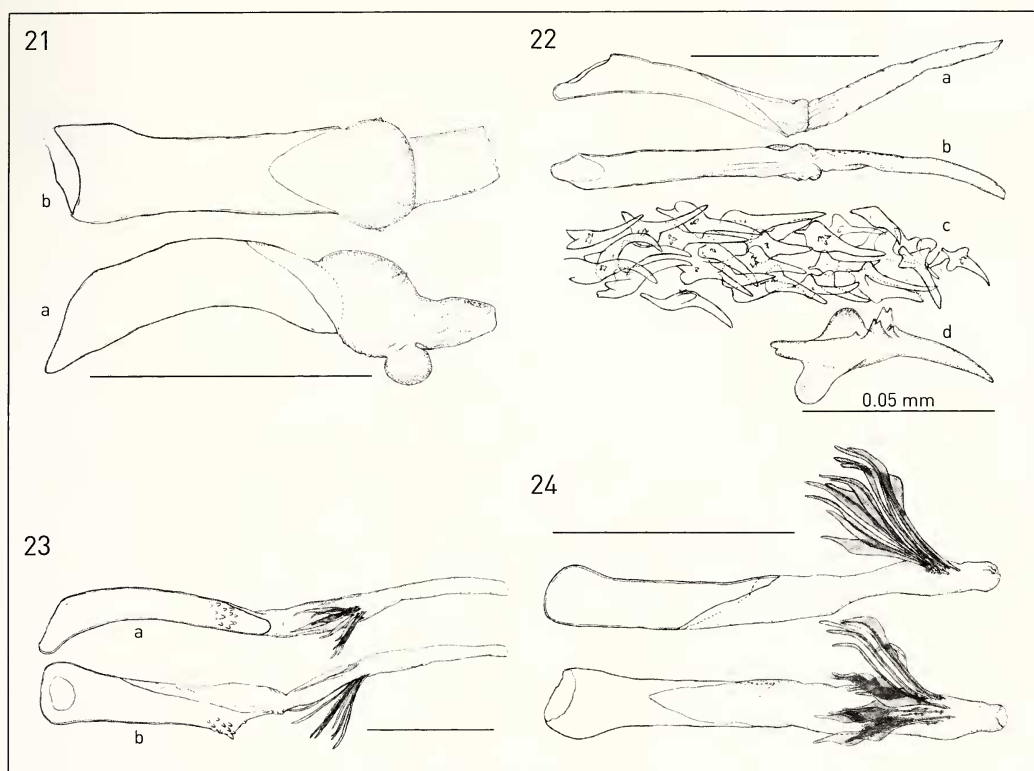
**Fig. 20**

Lph = 0,59 mm, Lv ~ 0,38 mm. Phallus slightly ventrally and laterally (at right) curved and lacking a coecum; dorsal and right side of the distal half membranous; vesica almost cylindrical, wider than the phallus and curved to the right. The ductus ejaculatorius is much narrower than vesica, which bears two groups of non-deciduous cornuti. Proximal group subdorsally located consisting of four long spines arranged in a row in line with the long axis. Distal group dorsolaterally located, on the left side comprising seven shorter cornuti arranged in two longitudinal rows.

***Pelatea klugiana* (Freyer, 1836)**

**Fig. 21**

Only one specimen was examined. Lph = 0,5 mm, Lv ~ 0,18 mm. Phallus cylindrical and slightly ventrally curved; distal third membranous dorsally; vesica very short, spherical bearing two tiny, indistinct prominences located dorsolaterally and a large, short and spherical ventral diverticulum.



**Figs 21–24.** Everted vesicae of Tortricidae. **21.** *Pelatea klugiana*. a. Left view. b. Dorsal view. **22.** *Ancyliis achatana*. a. Left view. b. Dorsal view. c. Bundle of cornuti. d. Single cornutus. **23.** *Thiodia citrana*. a. Left view. b. Dorsal view. **24.** *Epinotia abbreviana*. a. Left view. b. Dorsal view. Scale = 0.5 mm (except Fig. 22d).

### *Ancyliis achatana* (Denis & Schiffermüller, 1775)

**Fig. 22**

Lph = 0,62 mm, Lv = 0,37 mm. Phallus almost straight, narrow and cylindrical, with a very short coecum; distal third with membranous areas on both sides; vesica with two very indistinct diverticula located dorsolaterally on both sides. The cornuti are remarkable, numbering between 55 and 60, located on the right side, forming a compact group. They are deciduous and during eversion all of them were separated from the vesica as a compact formation. Their main part is cylindrical, sharp at the distal end and curved in the direction of vesica. In the basal half they have two flat lateral prominences. There is a group of several spicules located almost in the middle of each cornutus, located on side which is opposite to the vesica; each cornutus attached by a thin fragile slightly curved and terminally located neck (Fig. 31).

### *Thiodia citrana* (Hübner, 1796–99)

**Fig. 23**

Lph = 0,90 mm, Lv ~ 0,50 mm. Phallus dorsally curved and slightly narrowed apically; coecum very short. Only the proximal third of the right side is sclerotised; the remaining part is membranous and merges into the vesica. A large prominence is present at

the left side near the apex, covered by several blunt spines. The vesica is relatively short, cylindrical, bearing ca. 10 long, flat, lanceolate, deciduous cornuti located at the left side and pointed anteriorly. These are indistinctly S-shaped and joined by a small neck in their sub-apical region to the vesica. On the opposite side, the vesica has a slightly sclerotised plate and in non-everted vesica this plate envelops the cornuti as a semi-cylinder.

***Epinotia abbreviana* (Fabricius, 1794)**

**Fig. 24**

Lph = 0,50 mm, Lv ~ 0,40 mm. Phallus cylindrical and almost straight; opening located slightly laterally (on the right); coecum absent. Vesica cylindrical without any specific characters apart from 16 deciduous cornuti, ca. 0,35 mm long. These are S-shaped, flat, lanceolate and located on the dorsal side in a compact group directed anteriorly. Basal part relatively narrow, apical part wider, curved ventrally and tapering at the end. Each cornutus is joined to the vesica by a typical setal base, located subapically on the ventral side of the cornutus.

***Cydia amplana* (Hübner, 1796–99)**

**Fig. 25**

Lph = 0,90 mm, Lv ~ 0,40 mm. Phallus sinuate, the proximal part dorsoventrally flattened, wide and the distal part laterally flattened; opening terminally located, coecum absent. A short dentate crest on the left side of the apical part. Vesica short, membranous, dorsally directed to the right. The short and tubular base is followed by a wider and bulbous section with numerous longitudinal folds covered by very short fingerlike processes. This part is followed by the ductus ejaculatorius without any distinct boundary evident between them.

***Grapholita lunulana* (Denis & Schiffermüller, 1775)**

**Fig. 26**

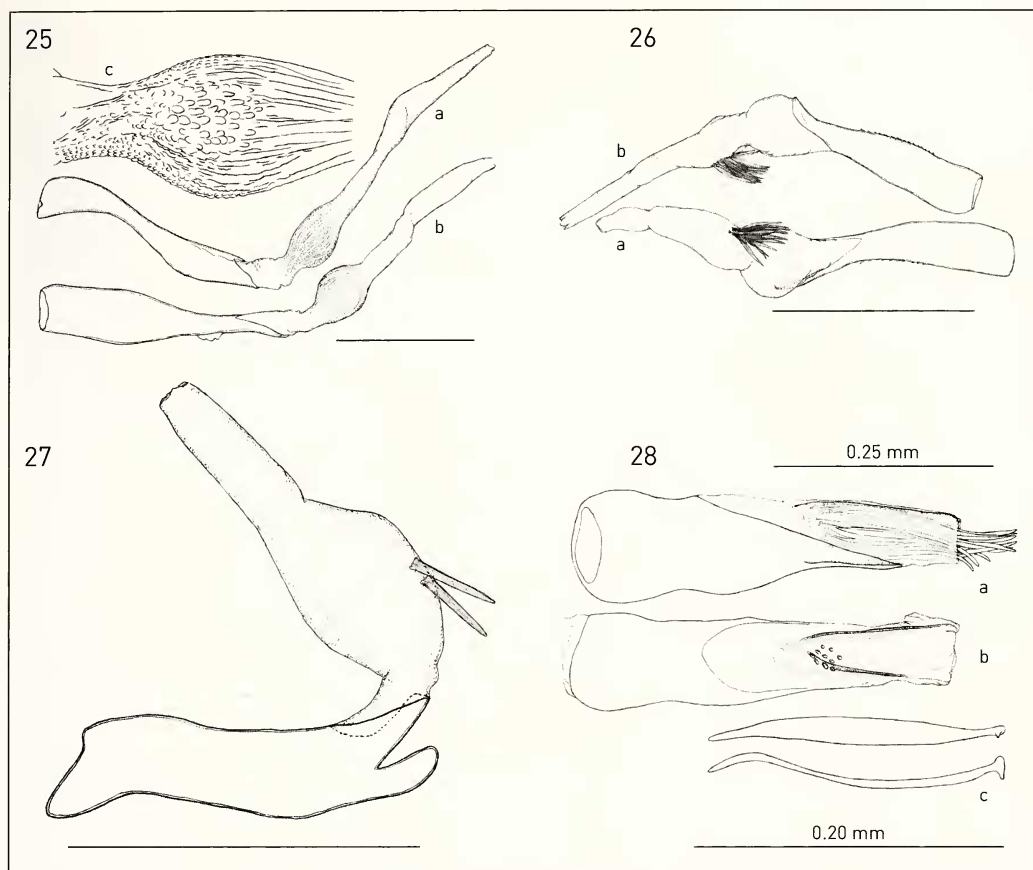
Lph = 0,58 mm, Lv ~ 0,3 mm. Phallus well sclerotised, distally narrowed, without a coecum; distal part slightly curved to the left; ventral and left surfaces with spicules; vesica relatively wide, dorsolaterally directed consisting of two parts: proximal section more or less spherical and almost twice as wide as the narrowest part of the phallus; distal section narrower, bulbous bearing a compact bundle of 13–15 anteriorly directed deciduous cornuti, similar to those found in *Epinotia* and *Thiodia*. Cornuti lanceolate, flat and wide, slightly sinuate; point of attachment subbasally located.

***Pammene splendidulana* (Guenée, 1845)**

**Fig. 27**

Lph = 0,57 mm, Lv ~ 0,35 mm. Phallus cylindrical, slightly dorsally bent, with a big fingerlike process on the ventral side of the apical part; opening terminally located, coecum missing. Basal part of vesica narrow, cylindrical, followed by a much wider,





**Figs 25–28.** Everted vesicae of Tortricidae. **25.** *Cydia amplana*. a. Left view. b. Dorsal view. c. Detail of vesica. **26.** *Grapholita lunulana*. a. Right view. b. Dorsal view. **27.** *Pammene splendidulana*. Left view. **28.** *Gypsonoma minutana*. a. Left view, vesica inverted. b. Dorsal view, vesica inverted, without cornuti. c. Single cornutus, ventral and lateral view. Scale = 0.5 mm.

dorsally-pointed bulbous part. There are two fixed, cylindrical, well-sclerotised cornuti on the ventral side, with bases socketed and similar to those of *E. marginana*, but a neck is absent.

## Discussion

Tortricid vesicae are rather variable but, with the exception of Cochylini, the main form is cylindrical. The vesica in the Tortricinae is usually longer and more variable when compared with the Olethreutinae. Both representatives of Tortricini (*Tortrix viridana* and *Acleris boscanoides*) are characterized by a cylindrical vesica with a large diverticulum at the right side bearing stout, socketed and fixed cornuti. The vesica is more variable in the Cochylini, and in all examined species is rather voluminous. In contrast to all other tribes, the gonopore is located laterally; the ductus ejaculatorius is much narrower than the vesica. Cornuti (if present) are non-deciduous, but obviously differ-

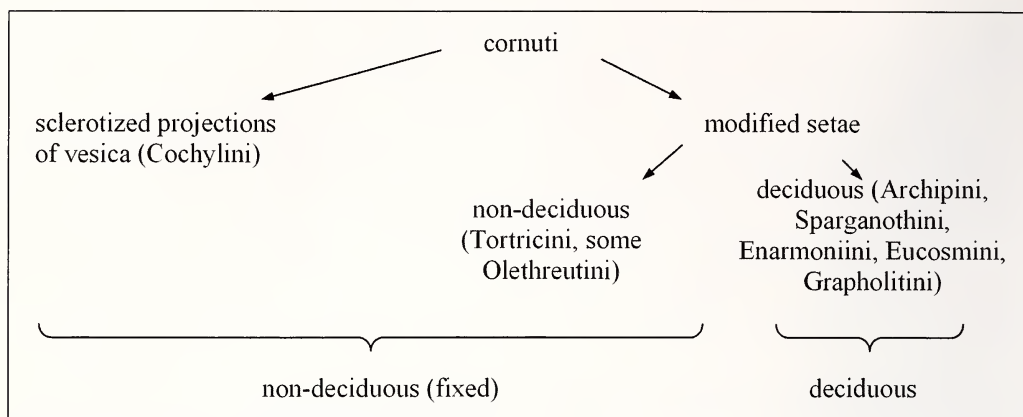
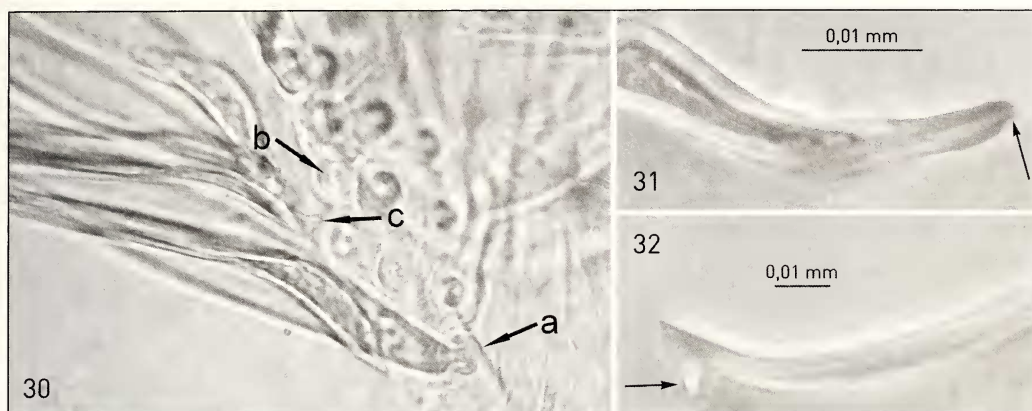


Fig. 29. Types of cornuti observed in Tortricidae.

ent in comparison to the other tribes. Apparently the cornuti in all examined Cochylini are sclerotised spiniform projections of the vesica. The vesica of Cnephasiini is relatively narrow, corresponding to a narrow phallus, simple, with a short bubble-shaped part. None of species studied possessed cornuti. The species of Archipini show several common characters in the design of the vesica. It is cylindrical, with an apical gonopore and deciduous or fixed cornuti are attached to the end of a diverticulum. Usually the vesica has a second diverticulum, without cornuti, located near the first one (see also Dang, op. cit.). Although only one representative of Sparganothini was examined, the vesica shows similarity with some Olethreutine species: it is large, apically narrowed and without a distinct boundary with the ductus. The cornuti are very long, as long as the phallus, deciduous, numerous and attached to the vesica with sockets, in the same way as in the Eucosmini and some Grapholitini – with a short neck located basolaterally on the cornutus. Moreover, the cornuti are slightly sinuate and directed anteriorly. Only one species from Chlidanthinae was studied and no conclusions on the structure of the vesica could be made. The vesica of *O. schumacherana* is similar to the Cnephasiini vesicae.

The vesica in the Olethreutinae is less varied, always with an apically located gonopore and often shortened. In *Bactra robustana* (Bactrini), the vesica is very simple, like a membranous extension of the phallus, very short, and without a distinct border with the ductus. In the Olethreutini the vesica is relatively varied, sometimes reduced (*Lobesia*) or shortened (*Pelatea*). The cornuti, if present, are non-deciduous, socketed, well sclerotised cylindrical spines. *Ancylis achatana* (Enarmoniini) has a long field with cornuti on the vesica; this field is restricted in the tribes described below. The deciduous cornuti are dorsoventrally flattened, similar to those in Eucosmini and Grapholitini, but the basal neck is apically located. The vesicae of all studied Eucosmini show significant similarity. They are tubular, relatively long and have a bundle of many (more than 10) deciduous, socketed lanceolate, flat cornuti attached to the vesica by a short basolateral neck, and always anteriorly directed. The other typical character is a sclerotised plate on the vesica, opposite the cornuti. It is visible without eversion as a semi-cylindrical



**Figs 30–32.** Details of structures of phalli in Tortricidae. **30.** Vesica with cornuti of *Grapholita lunulana*. a. intact setal base of cornutus; b. socketed base, cornutus has broken off; c. basolateral neck of cornutus broken off. **31.** Basal part of cornutus of *Ancylis achatana*. The arrow shows terminal and slightly curved fragile neck broken off. Phase contrast. **32.** Basal part of cornutus of *Gypsonoma minutana*. The arrow shows basolateral neck of the cornutus broken off. Phase contrast.

plate enveloping cornuti. In many cases this plate makes the vesica non-eversible (I did not managed to evert vesica of *Eucosma metzneriana* (Treitschke, 1830), *Gypsonoma minutana* (Hübner, 1796–99) (Fig. 28), *Epiblema graphanum* (Treitschke, 1835), *Notocelia uddmanniana* (Linnaeus, 1758), or *N. trimaculana* (Haworth, 1811)). The vesica of the Grapholitini is similar to that of the Eucosmini, but has a more prominent bulbous part. Cornuti, if present, may be deciduous and flat (e. g. *Grapholita*) as in Eucosmini or non-deciduous and cylindrical (e. g. *Pammene*) as in some Olethreutini. Usually, cornuti in the Tortricidae are divided into two types: deciduous and non-deciduous, but this classification appears to be artificial because of different origin of these types. I observed two further types of cornuti.

The first type includes sclerotised projections of the vesica. In fact they are non-deciduous. These cornuti are hollow and their cavities are not separated from the lumen of the vesica. This is typical for some Cochylini.

The second type includes structures certainly derived from setae. They are very common among many representatives of the family. Setaceous cornuti could be non-deciduous (fixed) or deciduous. Fixed cornuti are usually cylindrical, heavily sclerotised (Tortricini, Olethreutini), sometimes with an indistinct neck at the base (*Endothenia*). Deciduous cornuti are flat, tapered at both ends and have a basal (Archipini, Enarmoniini (Fig. 31)) or basolateral (Sparganothini, Eucosmini (Figs 28c, 32), Grapholitini) thin and fragile constriction (neck) which is broken during copulation (Fig. 30). Types of cornuti observed in Tortricidae are shown on Fig. 29.

## Conclusion

This modified eversion technique allows better inflation of the vesica for examination of its three-dimensional structure. Some species have a non-eversible vesica due to

presence of a sclerotised plate enveloping the cornuti. Usually the vesica in examined species is cylindrical and slightly wider than the distal end of the phallus. The gonopore is located terminally. In most cases the diameter of the vesica does not significantly exceed the diameter of ductus ejaculatorius. An exception to this rule is seen within the tribe Cochylini in which there is a very wide, voluminous vesica and a laterally located, narrow gonopore, respectively ductus ejaculatorius. It is most probable that the structure of the everted vesica could be used for resolving taxonomic problems in many genera. However, significant similarity in combination with simplicity of the vesicae in Eucosmini and Grapholitini may limit its usefulness. A careful study of specific characters (including number, position and morphology of cornuti, dimensions of vesica etc.) is likely to be useful for distinguishing closely related species.

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